IJSPT

ORIGINAL RESEARCH

COMPARISON OF LOWER QUARTER Y-BALANCE TEST SCORES FOR FEMALE COLLEGIATE VOLLEYBALL PLAYERS BASED ON COMPETITION LEVEL, POSITION, AND STARTER STATUS

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ABSTRACT

Background: The Lower Quarter Y-Balance Test (YBT-LQ) is used by sports medicine professionals to measure an athlete's dynamic balance. The YBT-LQ is used by clinicians to track recovery during clinical rehabilitation, assess an athlete's readiness to return to sport after injury, and to identify athletes potentially at-risk for a time-loss injury. Normative data for the YBT-LQ are lacking for female collegiate volleyball (VB) players. The purpose of this study was to examine preseason YBT-LQ scores and their relationships to level of competition, starter status, player position, and prior lower quadrant (i.e., low back and lower extremities) injury history.

Methods: One-hundred thirty-four female collegiate VB players (mean age = 19.3 ± 1.1 years) representing athletes from three levels of competition (D II = 32, D III = 77, NAIA = 25) participated in this study. Athletes reported their prior injury history and performed the YBT-LQ testing protocol.

Results: NAIA and D III athletes demonstrated significantly greater reach measures on the YBT-LQ than D II athletes in several directions. Starters demonstrated significantly greater reach measures in five out of eight reach directions. Liberos/defensive specialists/setters demonstrated significantly greater posterolateral and composite reach measures bilaterally. There was no difference in reach measures based on prior history of lower quadrant (low back and lower extremities) injury.

Conclusion: This study provides normative data for YBT-LQ in female collegiate volleyball players. The data presented in this report may be used by coaches and rehabilitation professionals when evaluating dynamic balance in healthy volleyball players and by clinicians to compare an injured athlete's recovery to norms.

Level of Evidence: 3b

Keywords: balance, college, functional test, Movement System, volleyball, Y-Balance Test-Lower Quarter

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DOI: 10.26603/ijspt20190415

INTRODUCTION

The Lower Quarter Y-Balance Test (YBT-LQ) is used by sports medicine professionals to measure an athlete's dynamic balance.[1] The YBT-LQ is a relatively new test inspired by the star excursion balance test.[2] The YBT-LQ is used by clinicians to track recovery during clinical rehabilitation, assess an athlete's readiness to return to sport after injury, and to identify athletes potentially at-risk for a time-loss injury.[2-12]

Assessing a patient's balance, as measured by the YBT-LQ, during clinical rehabilitation may help clinicians identify side-to-side asymmetries and/or general deficits when compared to normative data.[3,4,7,13] It is important to note that several studies have reported normative data for the YBT-LQ in various athletic and military populations.[14-23] YBT-LQ scores may differ between athletes based on sport participation, gender, or competition level; therefore a clinician should compare their patient's scores with those from a homogeneous sample.[16,18,24]

Only two studies have reported normative data for collegiate VB players with each study marked by limitations.[14,25] Hudson et al collected YBT-LQ measures in a population of National Collegiate Athletic Association (NCAA) Division I (D I) female collegiate VB players.[14] The authors reported YBT-LQ composite scores (a score that sums each reach distance normalized to limb length); however, they did not report individual reach measures.[14] Stiffler et al also collected measures using the shape of the "Y" (using the star excursion balance test and not the YBT test) from a population of D I female VB players reporting individual reach measures; however, the data represented measures from only 22 athletes and they did not use the YBT-LQ device.[25] There is also paucity in the literature regarding individual and composite YBT-LQ scores for female collegiate VB players from other divisions. In addition there is paucity regarding YBT-LQ scores for collegiate VB players based on player position, starter status, level of competition, and prior injury history. To address the aforementioned gaps in the literature additional studies are warranted.

The purpose of this study was to examine preseason YBT-LQ scores and their relationships to level of competition, starter status, player position, and prior lower quadrant (i.e., low back and lower extremities) injury history in female collegiate VB players. There were five hypothesis explored in this study. 1) NCAA D II and NAIA would have significantly greater YBT-LQ reach measures than NCAA D III VB players. 2): Starters would have significantly greater YBT-LQ reach measures than their non-starter counterparts. 3): VB athletes who play positions that require more vertical jumps (e.g., outside hitter, middle blocker, opposite hitter) would have significantly shorter YBT-LQ reach measures than their counterparts (e.g., setters, libero, defensive specialist). 4): D II and NAIA VB players would have significantly greater YBT-LQ scores, per position, than their D III counterparts. 5): VB athletes with prior history of time-loss lower quadrant (LQ = lower extremity and low back region) injury or prior history of time-loss lateral ankle sprain injury would have significantly shorter reach measures than those with no prior history of injury.

METHODS

Participants

Recruitment of VB players occurred in a two-step process. First, an investigator from each region contacted the team's head coach via either phone or email to recruit team participation. Next, if the head coach agreed to allow his/her team to be tested then an investigator from each region recruited team members, via email, to be tested at the investigators' labs. The data for this study was collected over a three-year period with testing occurring at two locations: George Fox University and Azusa Pacific University. The majority of athletes were tested in the George Fox University lab (n = 118). Investigators from each institution reviewed the standardized testing protocol prior to data collection.[1] One hundred and thirty-four female collegiate volleyball players, representing athletes from NCAA D II, NCAA D III, and NAIA teams, were tested over a three-year period. Informed consent was obtained from each subject prior to testing. The Institutional Review Boards of George Fox University and Azusa Pacific University approved this study.

Procedures

Collection of YBT-LQ measures occurred at the start of preseason as part of a larger study investigating the relationship between performance measures

and time-loss injury. Specific to this study each athlete performed a dynamic warm-up prior to testing, reported demographic information and prior injury history to the lower quadrant region (i.e., low back and lower extremities), and completed the YBT-LQ protocol.

Dynamic Warm-Up

Each athlete performed a five-minute dynamic warm-up prior to testing. Subjects performed the following movements at their own pace: forward walking, backward walking, heel walking, tip toe walking, marching, and hip flexion with opposite arm reach. Demographic information collected from each athlete included age, year in school, and age starting sport. Athletes also reported prior sport related injury history including injury location, diagnosis, and the date the injury occurred (month/year).

Y-Balance Test – Lower Quarter Protocol

The YBT-LQ protocol consisted of two steps: 1) test instruction and 2) test performance. Prior to performing the YBT-LQ each subject was provided test performance instruction and completed six warm-up trials per lower extremity (LE).[1] When performing the test an athlete would stand barefoot on the weightbearing platform with toes positioned behind the red indicator line. Next, the athlete would reach their non-weightbearing LE into one of the three components of the "Y" [anterior (ANT); posteromedial (PM); posterolateral (PL)] to slide the reach indicator (aka the moveable platforms). The anterior reach trials were performed first with the athlete performing three on the right (i.e., right LE weightbearing) followed by performing three reach trials on the left (i.e., left LE weightbearing).[1,26] After successfully completing three trials, per LE, in the ANT direction three trials per LE (right followed by left) were performed in the PM direction followed by the PL direction.[1,26]

A reach trial would be repeated by the athlete if she demonstrated any of the following common technique errors: loss of balance, maintaining one's balance by using the non-weightbearing limb, failing to slide the reach indicator under control (e.g. flicking it or kicking it forward), or moving the reach indicator forward by applying contact to the indicator outside of the red target region.[1,26] A successful trial was measured and recorded by the investigator.

YBT-LQ reach distance is normalized to the athlete's limb length. Limb length measurements were collected by the investigator after the athlete completed testing. The limb length measurements were obtained bilaterally with the athlete in supine measuring the distance from the anterior superior iliac spine to the distal aspect of the medial malleolus.[1,2] The following formula was used to calculate normalized reach distance measurements: ([reach distance / limb length] x 100) [note: right limb measurements were used to normalize right sided reach distances and left limb measurements were used to normalize reach distances on the left].[1,2] The composite reach score was calculated using this formula: ([mean ANT + mean PM + mean PL] / [limb length x 3]) x 100.[1,2] The intrarater reliability (0.85 – 0.91) and the interrater reliability (0.99 – 1.00) for the YBT-LQ have been previously reported.[1]

Statistical Analyses

Mean (± SD) scores were calculated for demographic variables and individual YBT-LQ reach measures. Independent t-tests were used to compare reach distance measures per starter status and per prior history of injury. Analysis of variance (ANOVA) was performed to compare demographic measures per level of competition and to compare YBT-LQ measures per level of competition, per player movement categorization (e.g., grouping based on vertical movements versus horizontal or lateral movements), and per player position. Statistical analyses was performed using SPSS 24.0 (Chicago, IL) for all calculations.

RESULTS

The mean age was 19.3 (± 1.1) years with NAIA athletes significantly older than D III players (Table 1). The mean number of years in school was 2.2 (± 1.1) years; the NAIA population of athletes had been in school significantly more years than D II or D III athletes. The mean age starting for this sport was 11.7 (± 2.1) years.

Individual and composite reach measures per level of competition and for the entire population are presented in Table 2. Several significant differences in reach distance, per level of competition, were found. NAIA athletes had significantly greater

Table 1. *Demographic Characteristics (Mean ± SD) for Female Collegiate Volleyball Players.*

Variable	Total Population (n = 134)	Division II (n = 32)	Division III (n = 77)	NAIA (n = 25)	p-value
Age (y)	19.3 (1.1)	19.3 (0.9)	19.1 (1.1)†	19.8 (1.2)†	0.034
Years in School	2.2 (1.1)	2.0 (1.0)¥	2.1 (1.0)‡	2.7 (1.2)¥‡	0.026
Age Starting Sport (y)	11.7 (2.1)	11.3 (2.3)	11.8 (1.9)	12.0 (2.4)	0.402

†Difference between NAIA and D III; p-value = 0.028 post-hoc
¥Difference between NAIA and D II; p-value = 0.050 post-hoc
‡Difference between NAIA and D III; p-value = 0.036 post-hoc

Table 2. *Comparison of Normalized Y-Balance Test – Lower Quarter Reach Measures (Mean ± SD) per Level of Competition and Starter Status.*

Characteristic	Right Anterior Reach	Right Posteromedial Reach	Right Posterolateral Reach	Right Composite Score	Left Anterior Reach	Left Posteromedial Reach	Left Posterolateral Reach	Left Composite Score
Level of Competition								
Totals (n = 134)	66.1 (6.6)	106.0 (10.6)	102.3 (11.0)	99.6 (13.0)	66.1 (6.4)	107.3 (9.6)	102.4 (10.5)	100.1 (12.1)
Division II (n = 32)	64.6 (5.9)	101.4 (8.1)†	96.4 (9.4)‡§	95.0 (8.9)	64.7 (6.6)¥	102.9 (8.4)*α	97.9 (9.6)↑	96.1 (8.7)
Division III (n = 77)	66.0 (6.8)	106.3 (11.3)	103.8 (11.1)§	101.6 (14.6)	65.7 (6.3)	107.6 (9.5)*	102.9 (10.4)	101.6 (13.3)
NAIA (n = 25)	68.4 (6.7)	111.2 (8.9)†	105.1 (10.6)‡	99.6 (13.0)	69.1 (5.8)¥	111.7 (9.4)α	106.4 (10.1)↑	100.8 (11.1)
p-value[a]	0.097	0.002†	0.002‡§	0.057	0.026¥	0.002*α	0.007↑	0.091
Starter Status								
Yes (n = 52)	67.6 (7.1)	108.4 (11.2)	104.5 (10.8)	101.7 (13.7)	67.6 (6.9)	109.7 (9.6)	105.4 (10.0)	102.4 (12.2)
No (n = 82)	65.2 (6.1)	104.6 (10.0)	100.9 (11.1)	98.3 (12.4)	65.1 (6.0)	105.7 (9.4)	100.5 (10.4)	98.7 (11.9)
p-value[b]	0.035	0.043	0.067	0.144	0.030	0.021	0.008	0.084

[a]p-value: comparison between level of competition; analysis of variance
[b]p-value: comparison between yes or no; independent t-test
†Difference between NAIA and D II; p-value = 0.001 post-hoc
‡Difference between NAIA and D II; p-value = 0.008 post-hoc
§Difference between D II and D III; p-value = 0.004 post-hoc
¥Difference between NAIA and D II; p-value = 0.03 post-hoc
αDifference between NAIA and D II; p-value = 0.001 post-hoc
*Difference between D II and D III; p-value = 0.049 post-hoc
↑Difference between NAIA and D II; p-value = 0.006 post-hoc

(R) posteromedial, (R) posterolateral, (L) anterior, (L) posteromedial, and (L) posterolateral reach distances than D II athletes. Division III athletes had significantly greater (R) posterolateral and (L) posteromedial reach distances than D II athletes.

Table 2 also presents YBT-LQ measures per starter status. A review of team statistics identified 52 athletes as starters (note: two athletes who were starters did not participate in testing). Analysis of YBT-LQ measures between starters/non-starters was performed for the entire population; comparisons per level of competition were not performed due to sample sizes. There were several reach directions where starters had significantly greater YBT-LQ measures than their non-starter counterparts (Table 2). Starters had significantly greater reach measures in the following directions: (R) anterior, (R) posteromedial, (L) anterior, (L) posteromedial, and (L) posterolateral.

There are six primary positions in volleyball: setter (S), defensive specialist (DS), libero (L), outside hitter (OH), middle blocker (MB), and opposite side hitter [OPP (aka right side hitter)]. Player positions were identified from team statistics. Some players were identified as having two player positions. The following frequencies per position were: L only = 1; DS only = 13; L/DS specialist = 10; setter S = 27; OH = 43; OPP = 8; MB = 21; MB/OPP = 11. Normalized reach measures per player movement categorization are presented in Table 3. Two player position groups were formed for the purpose of this research, based on movement categorization (e.g., grouping based on vertical movements versus horizontal or lateral movements): Group 1 consisted of

Table 3. *Normalized Reach Distance (Mean ± SD) per Player Movement Categorization.*

Normalized Reach Direction	Total Population (n = 134)	L/ DS/ S (n = 53)	OH/ MB/ OPP (n = 81)	p-value
Right Lower Extremity				
Anterior	66.1 (6.6)	67.1 (6.5)	65.5 (6.6)	0.172
Posteromedial	106.0 (10.6)	108.0 (10.7)	104.8 (10.5)	0.089
Posterolateral	102.3 (11.0)	106.1 (10.7)	99.8 (10.6)	0.001
Composite	99.6 (13.0)	106.9 (12.8)	94.8 (10.8)	0.000
Left Lower Extremity				
Anterior	66.1 (6.4)	66.3 (6.4)	65.9 (6.5)	0.720
Posteromedial	107.3 (9.6)	109.0 (9.5)	106.1 (9.6)	0.093
Posterolateral	102.4 (10.5)	105.8 (9.1)	100.1 (10.8)	0.002
Composite	100.1 (12.1)	107.0 (11.4)	95.6 (10.4)	0.000

L = libero; DS = defensive specialist; S = setter; OH = outside hitter; MB = middle blocker; OPP = opposite (aka right side hitter)

L, DS, S; group 2 consisted of OH, MB, OPP. Athletes in Group 1 (L, DS, S) had significantly greater right and left sided posterolateral and composite reach measures than their counterparts in Group 2.

Analysis of normalized reach distance per level of competition and player position are presented in Table 4 (note: many athletes were designated as playing two positions; specifically libero/defensive specialist and middle blocker/opposite hitter; therefore liberos and defensive specialists were combined into one group and middle blockers and opposite hitters were combined into one group). NAIA L/DS had significantly greater (R) anterior, (R) posterolateral, (L) posteromedial, and (L) posterolateral reach measures than their D II counterparts. D III L/DS also had significantly greater (R) posterolateral and (L) posteromedial reach measures than D II athletes. No other significant relationships were found.

There were no significant differences in YBT-LQ reach measures based on prior history of injury (Table 5). In addition to the data presented in Table 5 a comparison between athletes with or without prior history of anterior cruciate ligament reconstruction (ACLR) was also performed. There were a total of eight athletes with prior history of ACLR (right = 4; left = 4). There were no differences in reach measures between groups based on ACLR history or based on involved limb.

DISCUSSION

This study presents the largest set of YBT-LQ data for female collegiate VB players and the first to present test measures for D II, D III, and NAIA levels of competition. The data presented in this study may be of benefit to clinicians who use this test to evaluate patient status during rehabilitation.

There were five hypothesis explored in this study. It was hypothesized (H1) that D II and NAIA VB players would have greater reach measures than D III athletes. This was hypothesized because D II and NAIA schools can offer scholarships; therefore they may be able to recruit athletes who score better on physical performance tests.[27,28] However, there were several reach directions where NAIA athletes had significantly greater measures than D II athletes. In addition, D III athletes had some greater reach measures than D II athletes. It could be speculated that differences in YBT-LQ performance in this study may be related to the significant differences in age between NAIA/ D III athletes and D II athletes. However, a prior study of high school, collegiate, and professional level baseball players reported that high school athletes (i.e., younger athletes) had significantly greater anterior reach measures.[18] The differences in scores between competition levels in this study may not be a result of athlete age; rather it may reflect differences in training programs between schools. A future study would be warranted to compare training programs and YBT-LQ performance.

It was hypothesized (H2) that starters would have greater reach measures than non-starters. In five out of eight measures starters had significantly greater scores than non-starters. This finding confirms our hypothesis that athletes who earn more playing time

Table 4. *Comparison of YBT-LQ Scores per Player Position(s) and Level of Competition.*

Normalized Reach Direction and Level of Competition	Libero / Defensive Specialist		Setter		Outside Hitter		MB and Opposite	
	(#)	Mean (SD)	(#)	Mean (SD)	(#)	Mean (SD)	(#)	Mean (SD)
Right Lower Extremity								
Anterior								
Division II	(6)	61.2 (4.1)†	(6)	63.0 (5.4)	(11)	66.1 (7.1)	(9)	66.0 (5.3)
Division III	(5)	70.1 (9.6)	(16)	67.0 (6.1)	(24)	65.7 (7.1)	(32)	65.2 (6.3)
NAIA	(11)	69.7 (5.6)†	(5)	64.6 (8.5)	(8)	68.0 (7.0)	(1)	75.5
Totals	(22)	67.5 (7.2)	(27)	65.7 (6.4)	(43)	66.3 (7.0)	(42)	65.6 (6.2)
p-value		0.036†		0.415		0.729		0.261
Posteromedial								
Division II	(6)	102.6 (9.0)	(6)	98.0 (7.9)	(11)	104.6 (8.2)	(9)	98.8 (7.3)
Division III	(5)	112.9 (15.1)	(16)	107.0 (10.4)	(24)	106.7 (9.9)	(32)	104.7 (12.1)
NAIA	(11)	113.5 (10.0)	(5)	110.6 (7.4)	(8)	108.6 (8.9)	(1)	108.5
Totals	(22)	110.4 (11.6)	(27)	105.7 (10.1)	(43)	106.5 (9.2)	(42)	103.5 (11.3)
p-value		0.153		0.082		0.646		0.360
Posterolateral								
Division II	(6)	91.8 (6.9)‡¥	(6)	100.1 (8.9)	(11)	98.8 (10.1)	(9)	94.1 (9.8)
Division III	(5)	109.5 (13.7)¥	(16)	104.9 (10.8)	(24)	101.6 (11.3)	(32)	104.0 (10.8)
NAIA	(11)	109.2 (10.0)‡	(5)	105.7 (9.5)	(8)	99.9 (11.2)	(1)	98.7
Totals	(22)	104.5 (12.6)	(27)	104.0 (10.0)	(43)	100.6 (10.8)	(42)	101.8 (11.1)
p-value		0.008‡¥		0.580		0.761		0.056
Composite								
Division II	(6)	98.8 (5.7)	(6)	96.7 (7.8)	(11)	97.1 (10.8)	(9)	88.9 (6.8)
Division III	(5)	115.5 (24.3)	(16)	104.2 (12.5)	(24)	98.8 (11.3)	(32)	100.1 (15.1)
NAIA	(11)	101.6 (12.8)	(5)	101.3 (11.3)	(8)	96.0 (9.7)	(1)	92.4
Totals	(22)	104.0 (15.5)	(27)	102.0 (11.4)	(43)	97.9 (10.7)	(42)	97.6 (14.3)
p-value		0.158		0.400		0.801		0.106
Left Lower Extremity								
Anterior								
Division II	(6)	61.2 (8.2)	(6)	63.3 (3.8)	(11)	65.4 (7.7)	(9)	67.0 (5.4)
Division III	(5)	72.6 (7.2)	(16)	65.6 (6.4)	(24)	65.4 (6.9)	(32)	64.8 (5.3)
NAIA	(11)	68.9 (7.1)	(5)	67.3 (4.3)	(8)	69.5 (5.0)	(1)	76.3
Totals	(22)	67.6 (8.3)	(22)	65.4 (5.6)	(43)	66.2 (6.9)	(42)	65.6 (5.5)
p-value		0.049		0.493		0.317		0.081
Posteromedial								
Division II	(6)	102.0 (8.1)§†	(6)	100.8 (9.1)	(11)	105.8 (9.1)	(9)	101.3 (7.8)
Division III	(5)	118.4 (9.5)§	(16)	109.4 (8.4)	(24)	107.5 (9.0)	(32)	105.1 (9.4)
NAIA	(11)	114.6 (8.6)†	(5)	112.8 (12.4)	(8)	107.9 (8.3)	(1)	105.6
Totals	(22)	112.1 (10.5)	(27)	108.1 (9.9)	(43)	107.1 (8.8)	(42)	104.3 (9.0)
p-value		0.011§†		0.094		0.839		0.541
Posterolateral								
Division II	(6)	96.5 (6.7)Δ	(6)	98.7 (8.8)	(11)	99.1 (10.1)	(9)	96.9 (12.2)
Division III	(5)	108.5 (15.2)	(16)	105.0 (8.6)	(24)	101.7 (10.9)	(32)	101.9 (10.1)
NAIA	(11)	111.0 (10.3)Δ	(5)	106.6 (8.6)	(8)	100.8 (9.0)	(1)	102.3
Totals	(22)	106.5 (12.1)	(27)	103.9 (8.8)	(43)	100.8 (10.2)	(42)	100.8 (10.5)
p-value		0.046Δ		0.252		0.783		0.452
Composite								
Division II	(6)	100.5 (6.2)	(6)	96.8 (6.4)	(11)	97.4 (10.6)	(9)	91.0 (14.3)
Division III	(5)	118.0 (20.6)	(16)	104.8 (10.8)	(24)	99.3 (10.8)	(32)	99.2 (13.4)
NAIA	(11)	103.0 (12.7)	(5)	103.9 (12.3)	(8)	96.8 (8.1)	(1)	92.9
Totals	(22)	105.7 (14.6)	(27)	102.9 (10.4)	(43)	98.3 (10.1)	(42)	97.3 (12.6)
p-value		0.093		0.400		0.796		0.215

†Difference between NAIA and D II; p-value = 0.05 post-hoc
‡Difference between NAIA and D II; p-value = 0.01 post-hoc
¥Difference between D III and D II; p-value = 0.031 post-hoc
§Difference between D III and D II; p-value = 0.017 post-hoc
↑Difference between NAIA and D II; p-value = 0.03 post-hoc
ΔDifference between NAIA and D II; p-value = 0.047 post-hoc

(i.e., starter) would have statistically better reach scores. It is currently unknown if dynamic balance, as measured by the YBT-LQ, is correlated with sport performance. This finding of greater reach distance measures in VB starters warrants further investigation.

It was hypothesized (H3) that athletes who play positions that require more vertical jumps would have significantly lower YBT-LQ measures than athletes who play positions that require more horizontal and lateral movements. OH, MB, and OPP are VB player

Table 5. *Comparison of YBT-LQ Scores (Mean ± SD) per Prior History of Time-Loss Lower Quadrant Injury, Lateral Ankle Sprain History, and Lateral Ankle Sprain within the Past 12 Months.*

Characteristic	Right Anterior Reach	Right Posteromedial Reach	Right Posterolateral Reach	Right Composite Score	Left Anterior Reach	Left Posteromedial Reach	Left Posterolateral Reach	Left Composite Score
Prior History of Lower Quadrant Injury								
Yes (n = 96)	65.6 (6.4)	106.5 (10.5)	101.7 (11.3)	98.9 (12.8)	65.7 (6.5)	107.3 (9.3)	101.7 (10.7)	99.4 (11.6)
No (n = 38)	67.5 (7.1)	105.0 (11.1)	103.7 (10.5)	101.5 (13.5)	67.0 (6.4)	107.1 (10.4)	104.0 (10.0)	102.1 (13.2)
p-value	0.130	0.483	0.367	0.302	0.283	0.875	0.263	0.245
Prior History of Lateral Ankle Sprain								
Yes (n = 47)	64.9 (6.4)	105.5 (10.6)	100.5 (11.6)	97.5 (11.9)	65.8 (6.1)	106.4 (9.2)	101.4 (11.1)	98.6 (10.9)
No (n = 87)	66.8 (6.7)	106.4 (10.7)	103.2 (10.7)	100.8 (13.5)	66.2 (6.7)	107.7 (9.9)	102.9 (10.2)	101.0 (12.7)
p-value	0.122	0.647	0.182	0.164	0.680	0.461	0.440	0.268
Prior History of Lateral Ankle Sprain in Previous 12 months								
Yes (n = 12)	66.5 (5.0)	104.2 (11.5)	94.1 (13.3)	94.0 (10.3)	67.5 (5.5)	104.3 (8.2)	97.9 (12.4)	95.8 (8.3)
No (n = 122)	66.1 (6.8)	106.2 (10.6)	103.1 (10.5)	100.2 (13.1)	65.9 (6.5)	107.6 (9.7)	102.8 (10.2)	100.6 (12.4)
p-value	0.818	0.524	0.007	0.116	0.426	0.266	0.119	0.192

positions that frequently require vertical jumps (e.g., hitting, blocking). Prior research has suggested that there is no correlation between jump performance and balance.[29,30] In contrast to the aforementioned "jumping" positions, S, DS, and L are player positions that require horizontal and lateral movements (e.g., laterally lunging to dig the ball) and therefore may require greater levels of dynamic balance. In this study there were four reach measures that were significantly greater in the L/DS/S group including both posterolateral reach measures.

It was hypothesized (H4) that D II and NAIA VB athletes would have greater scores per player position than D III athletes. Similar to the findings associated with H1 there were some instances where NAIA and D III athletes had greater reach measures, per the combined L/DS group, than D II athletes. The difference in reach measures between D II and NAIA/D III athletes may reflect differences in training programs between volleyball teams. In most cases, there were no significant differences in reach measures per level of competition. This was likely due to some smaller player position subgroups and therefore requires future investigation.

It was hypothesized (H5) that VB athletes with a prior history of injury would have significantly lower YBT-LQ measures than those without prior injury history. There are numerous examples in the literature identifying residual deficits in patients post-ACLR or post-ankle sprain despite having been discharged from clinical rehabilitation.[31-39] There were no differences in reach measures based on injury history in this study. This finding may be the result of one or more of the following reasons: 1) formerly injured athletes may have been adequately rehabilitated and/or 2) the YBT-LQ is not an effective test for identifying deficits in "healthy" athletes who had prior history of injury.

There are several strengths to this study. First, this study measured a large sample (n = 134) and included VB athletes from several levels of collegiate competition. Second, this study provides normative data for VB players based on level of competition, starter status, and player position. This normative data may be useful to rehabilitation professionals when tracking a patient's progress during therapy and to guide decision making as to whether an athlete is able to return to sport. There are a few limitations to this study. First, although athletes were recruited from several collegiate competition levels, there were no D I athletes assessed in this study. As previously mentioned there are two studies that have reported some YBT-LQ data for the D I population.[14,25] While a statistical comparison between the D I YBT-LQ measures in Hudson et al[14] and Stiffler et al[25] and the scores in the current study cannot

be made it is interesting to note similarities and differences in composite scores between groups. Hudson et al[14] reported composite scores, based on dominant/non-dominant limb and player position ranging between approximately 92 to 95 percent of limb length. In the current study composite scores were 106.9 (± 12.8) on the right and 107.0 (± 11.4) on the left with variations based on level of competition and player position. One must be cautious though when comparing the results from this study with those in Stiffler et al.[25] Stiffler et al[25] had subjects reach into each direction of the "Y"; however, they did not use the YBT-LQ device (essentially the subjects performed the star excursion balance test in the anterior, posteromedial, and posterolateral directions).[25] One might assume that performance on the YBT-LQ would be similar to performance on the SEBT; however, subjects reach further into the anterior direction during the star excursion balance test than when performing the YBT-LQ.[40,41]

CONCLUSIONS

The results of the current study provide normative YBT-LQ data for DII, DIII, and NAIA female collegiate volleyball players. This study found that NAIA and DIII athletes had several reach measures that were significantly greater than their DII counterparts. Also, starters had significantly greater reach scores than nonstarters. There were also significant differences in reach scores based on player positions. The descriptive data presented in this study may help coaches and sports medicine professionals when assessing a female volleyball player's dynamic balance and when evaluating and tracking balance during a course of rehabilitation.

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